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► To cite this version:

Margaux Izac, Eléa Rossignol, Emeline Pierrieau, Léa Pillette, Franck Di Rienzo, et al.. What brain patterns should we reinforce during BCI training procedures targeting motor imagery abilities? An experimental study on athletes. BCI Meeting 2023, Jun 2023, Bruxelles, Belgium. hal-04130256

HAL Id: hal-04130256

<https://hal.science/hal-04130256>

Submitted on 15 Jun 2023

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What brain patterns should we reinforce during BCI training procedures targeting motor imagery abilities?

An experimental study on athletes

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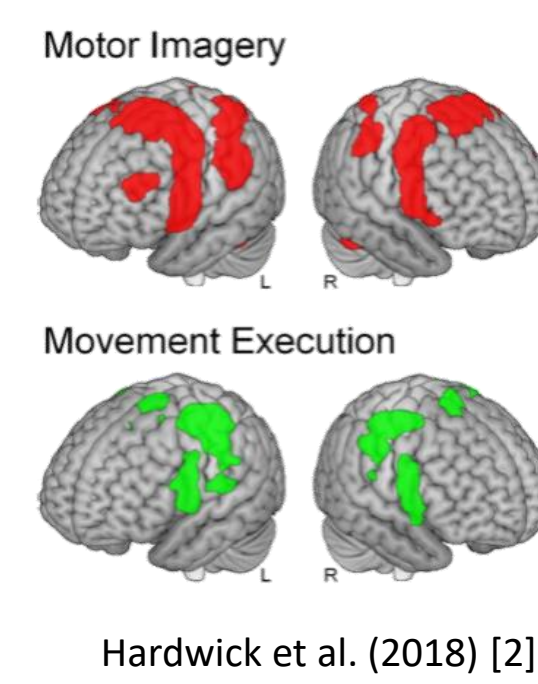
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Introduction

Motor imagery (MI)

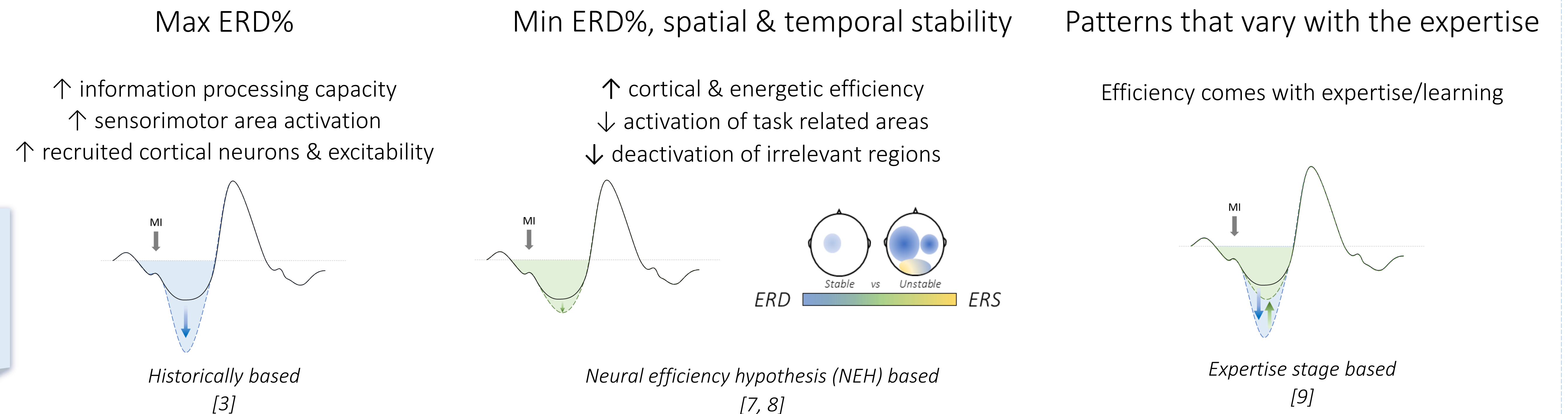
Mental simulation of an action without movement

- ↑ motor learning (e.g. technique) [1]
- Solicitates similar regions as movement execution [2]
- Is associated with an event-related desynchronisation (ERD) of sensorimotor rhythms (SMR) [3]



Research question

BCI training can enhance MI performance, but what brain activity patterns should we reward?



MI performance variations

≠ brain activities are observed depending on :

- MI type (visual or kinesthetic) [4]
- ability (vividness, control...) [5]
- practice (frequency, context...)
- Mastery of the task that is imagined [6]

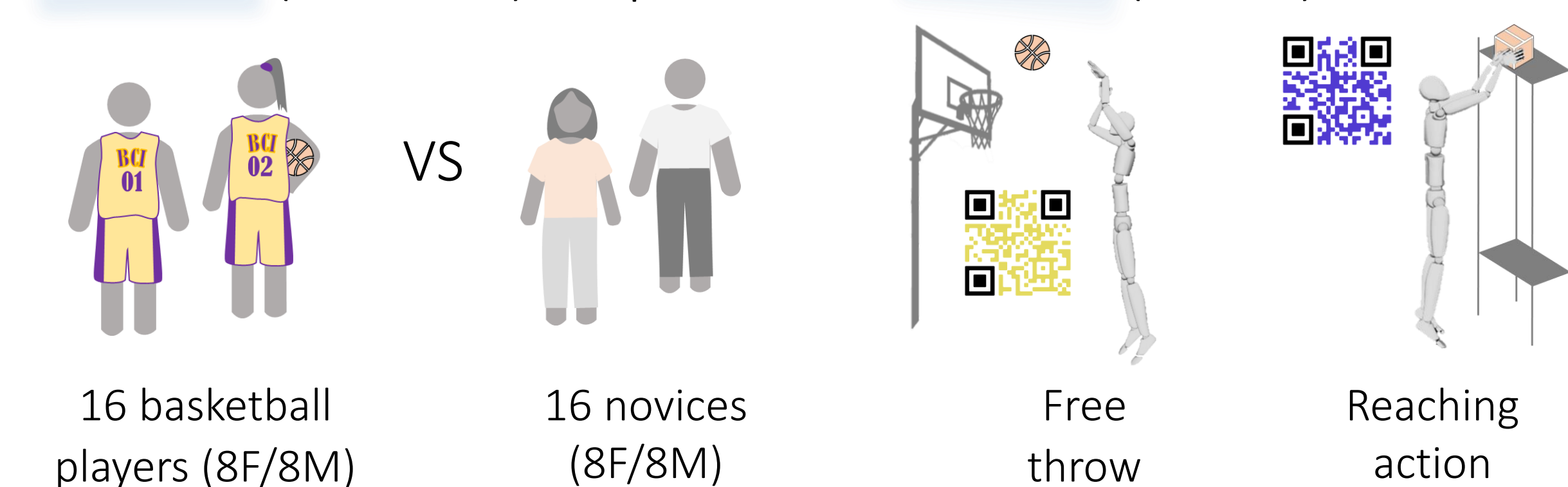
An "expert" can be a specialist in MI, in the imagined task or both. Athletes, musicians & gamers are often both as their activities require MI use in learning processes or anxiety management.

Methods

Mixed experimental design

Factor 1 (between) : Expertise

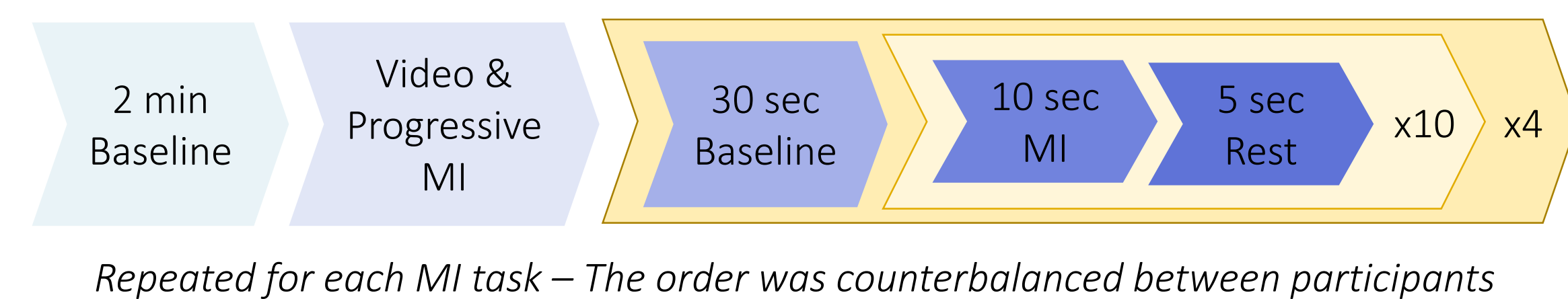
Factor 2 (within) : MI task



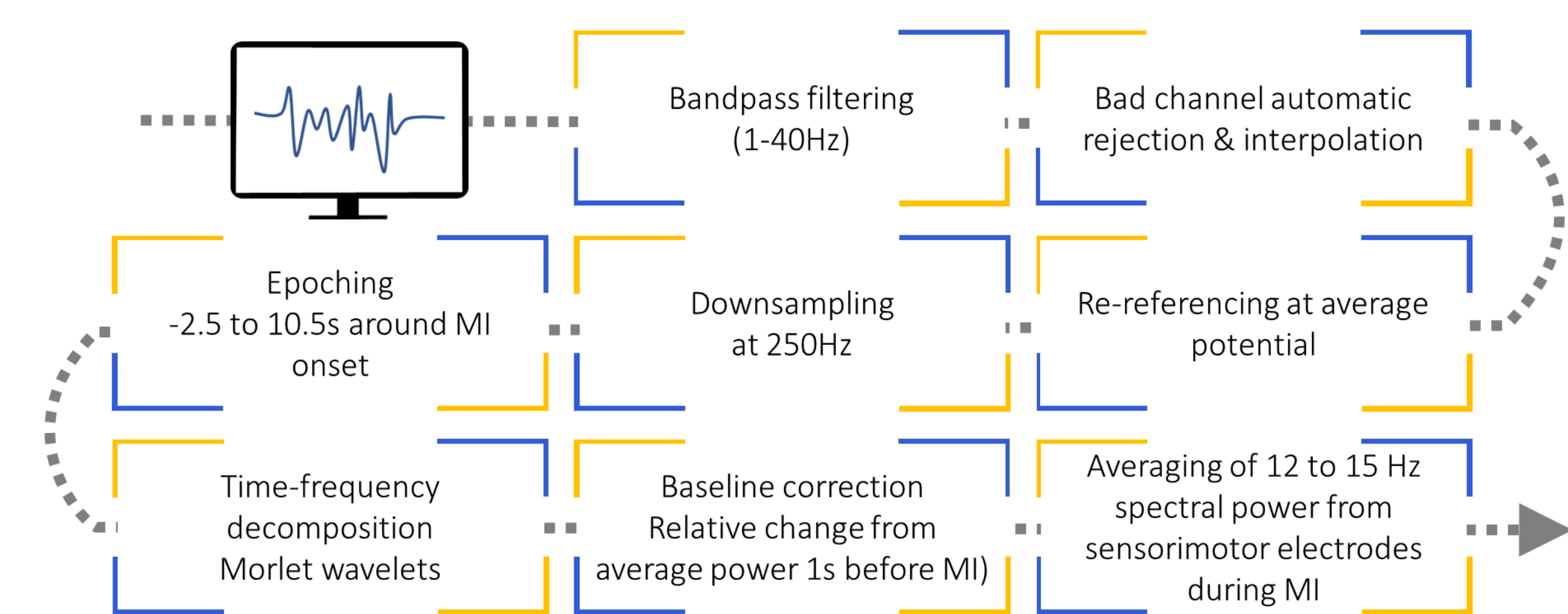
2 dependent variables :

- SMR-ERD | % of desynchronisation compared to pre-trial baseline
- Perceived MI ability | MIQ-3f [10] items measuring MI abilities for each task

Experimental procedure

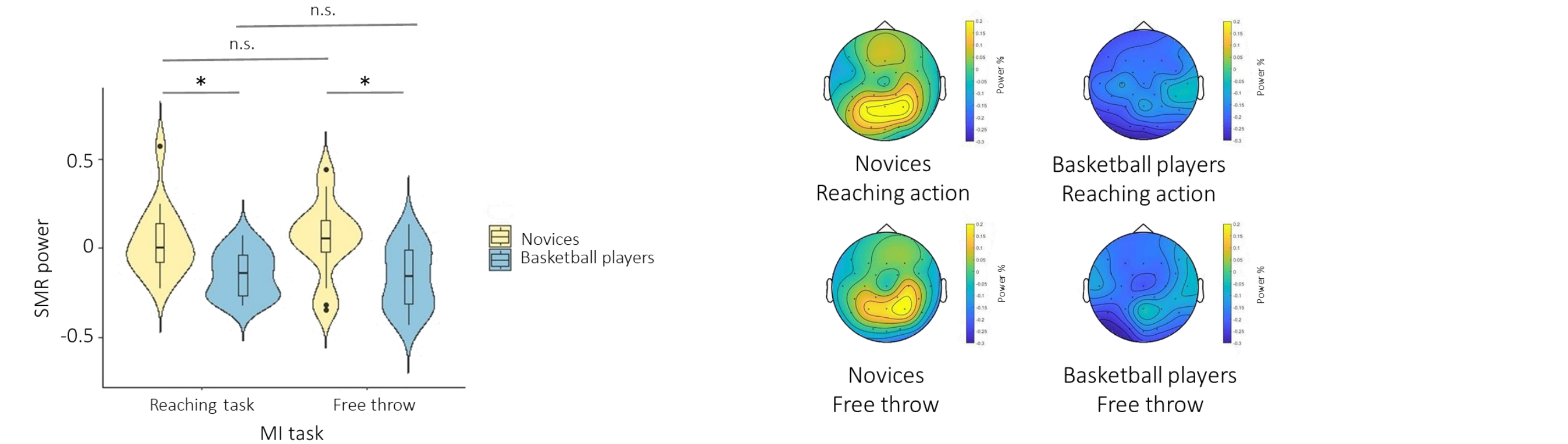


Pre-processing



Preliminary results

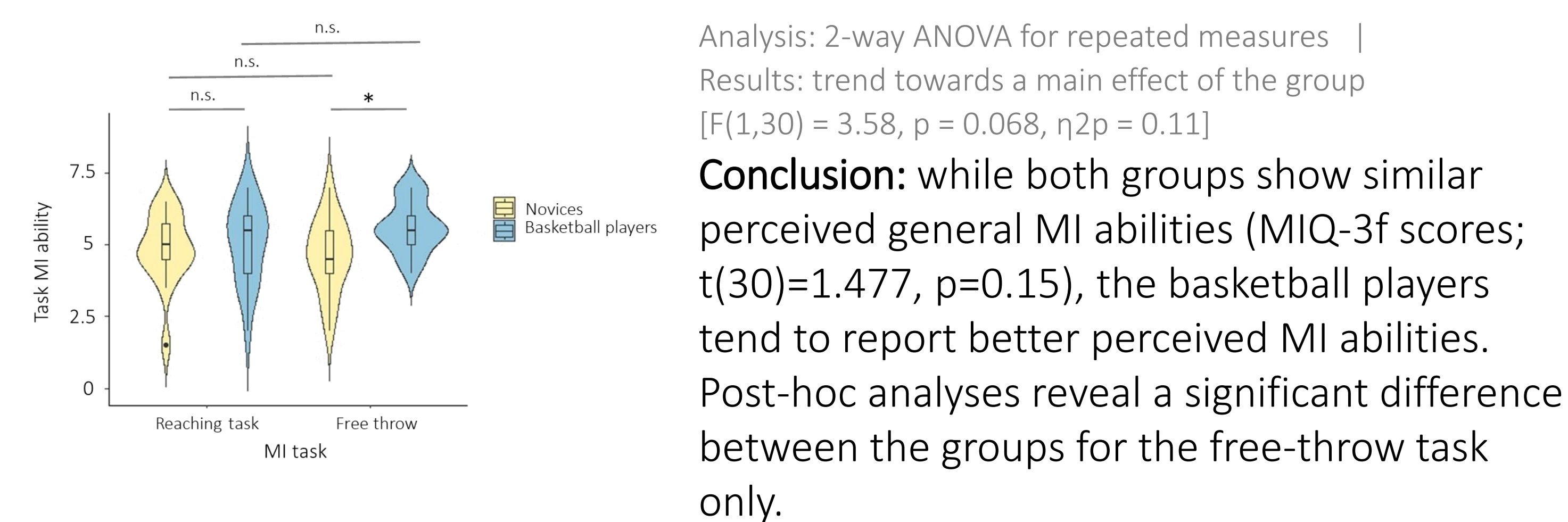
Effects of the MI task & expertise on SMR-ERD



Analysis: 2-way ANOVA for repeated measures | Results: main effect of the group [F(1,29) = 11.1, p = 0.002, η²p = 0.28]

Conclusion: basketball players significantly decrease their SMR power around sensorimotor regions to a greater extent than novices; basketball players show a stronger SMR-ERD during the free-throw MI task than during the reaching action.

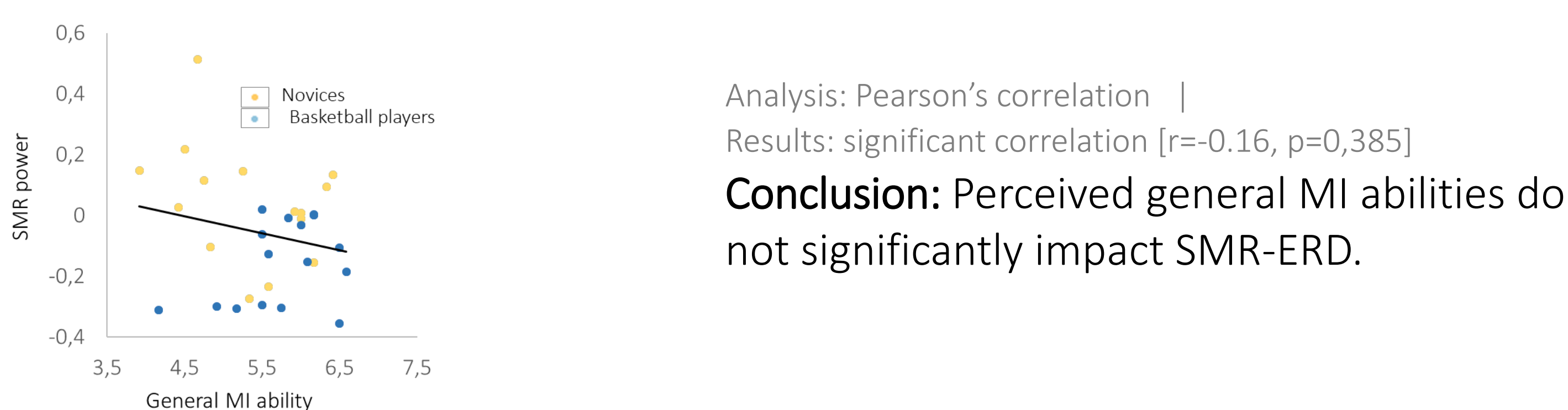
Effects of the MI task & expertise on perceived MI abilities



Analysis: 2-way ANOVA for repeated measures | Results: trend towards a main effect of the group [F(1,30) = 3.58, p = 0.068, η²p = 0.11]

Conclusion: while both groups show similar perceived general MI abilities (MIQ-3f scores; t(30)=1.477, p=0.15), the basketball players tend to report better perceived MI abilities. Post-hoc analyses reveal a significant difference between the groups for the free-throw task only.

Correlations between SMR-ERD & perceived MI abilities



Analysis: Pearson's correlation | Results: significant correlation [r=-0.16, p=0.385]

Conclusion: Perceived general MI abilities do not significantly impact SMR-ERD.

Summary

- Athletes show greater SMR-ERD than novices during MI whatever the imagined task, which suggests acquisition of "non task-specific" skills.

Discussion

- MI ability may need to be decomposed into ≠ dimensions that could correlate with SMR-ERD.
 - Further analysis will consider MI frequency of practice as responses to the Imagery Use Questionnaire [11] were recorded.
- Results go in the "historical based" or "expertise stage based" approaches direction.
 - As MI ability might only be significantly ≠ for high level athletes, further inclusion will be needed to see if SMR-ERD fluctuates according to expertise stage.

Opinions

- How do you think ERD% evolves with expertise?
- Should we be using other target metrics for BCI/NF training?
- If so, which ones and how?

References

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